DAFTAR PUSTAKA

Abriyani, E., Fikayuniar, L., dan Safitri, F., 2021. Skrining Fitokimia dan Bioaktivitas Antioksidan Ekstrak Metanol Bunga Kangkung Pagar *(Ipomoea carnea Jack*.) dengan Metode DPPH (2,2-Difenil-1-Pikrilhidrazil). Pharma Xplore. 6(1), 32-42.

Aini, N., dan Amaria, A., 2022. Sintesis Nanopartikel Au-SiO_2 Menggunakan Natrium Silikat dari Abu Ampas Tebu (AAT). Unesa Journal of Chemistry. 11(3), 143-152. https://doi.org/10.26740/ujc.v11n3.p143-152.

Ali, A. T., dan Karem, L. K. A., 2024. Biosynthesis, Characterization, Adsorption and Antimicrobial Studies of Manganese Oxide Nanoparticles Using Punica Granatum Extract. Baghdad Science Journal. 21(3), p.0952. https://doi.org/10.21123/bsj.2023.8183.

David, A., dan Kumar, R., 2022. Biogenesis of MnO_2 Nanoparticles Using *Momordica charantia* Leaf Extract. ECS Transactions. 107(1), 747. https://doi.org/10.1149/10701.0747ecst.

Dessie, Y., Tadesse, S., dan Eswaramoorthy, R., 2020. Physicochemical Parameter Influences and Their Optimization on the Biosynthesis of MnO_2 Nanoparticles Using *Vernonia amygdalina* Leaf Extract. Arabian Journal of Chemistry. 13(8), 6472-6492. https://doi.org/10.1016/j.arabjc.2020.06.006.

Dewi, N. O. M., dan Yulizar, Y., 2020. *Euphorbia heterophylla* L. Leaf Extract-Mediated Synthesis of MnO_2 Nanoparticles and Its Characterization. Materials Today: Proceedings. 22,199-204. https://doi.org/10.1016/j.matpr.2019.08.088.

Erildawati dan Zahrina., 2023. Telaah Senyawa Metabolit Sekunder dari Air Gebang dan Pelepah Pisang (*Corypha utan*). Jurnal Ilmiah Mahasiswa Jurusan Pendidikan Kimia. 8(1), 22-28.

Kurnianto, E., Rahman, I. R., dan Hairunnisa., 2021. Skrining Fitokimia Ekstrak Etanol Daun Matoa yang Berasal dari Pontianak Timur dengan Variasi Konsentrasi Pelarut. Jurnal Komunitas Farmasi Indonesia. 1(2), 31-38.

Lembang, E. Y., 2013. Sintesis Nanopartikel Perak Dengan Metode Reduksi Menggunakan Bioreduktor Ekstrak Daun Ketapang *(Terminalia catappa).* Disertasi. Universitas Hasanuddin.

Mekuria, A. T., 2024. Biosynthesis of Manganese Dioxide Nanoparticles and Optimization of Reaction Variables. Journal of Nanotechnology and Nanomaterials. 5(1), 31-45. https://doi.org/10.33696/Nanotechnol.5.052.

Moon, S. A., Salunke, B. K., Alkotaini, B., Sathiyamoorthi, E., dan Kim, B. S., 2015. Biological Synthesis of Manganese Dioxide Nanoparticles by *Kalopanax pictus* Plant Extract. IET Nanobiotechnology. 9(4), 220-225. https://doi.org/10.1049/iet-nbt.2014.0051.

Morales-Lozoya, V., Espinoza-Gómez, H., Flores-López, L. Z., Sotelo-Barrera, E. L., Núñez-Rivera, A., Cadena-Nava, R. D., dan Rivero, I. A. 2021. Study of the effect of the different parts of Morinda citrifolia L.(noni) on the green synthesis of silver nanoparticles and their antibacterial activity. Applied Surface Science, 537, 147855. https://doi.org/10.1016/j.apsusc.2020.147855

Najahi-Missaoui, W., Arnold, R. D., dan Cummings, B. S., 2020. Safe nanoparticles: are we there yet?. International Journal of Molecular Sciences. 22(1), 385. https://doi.org/10.3390/ijms22010385.

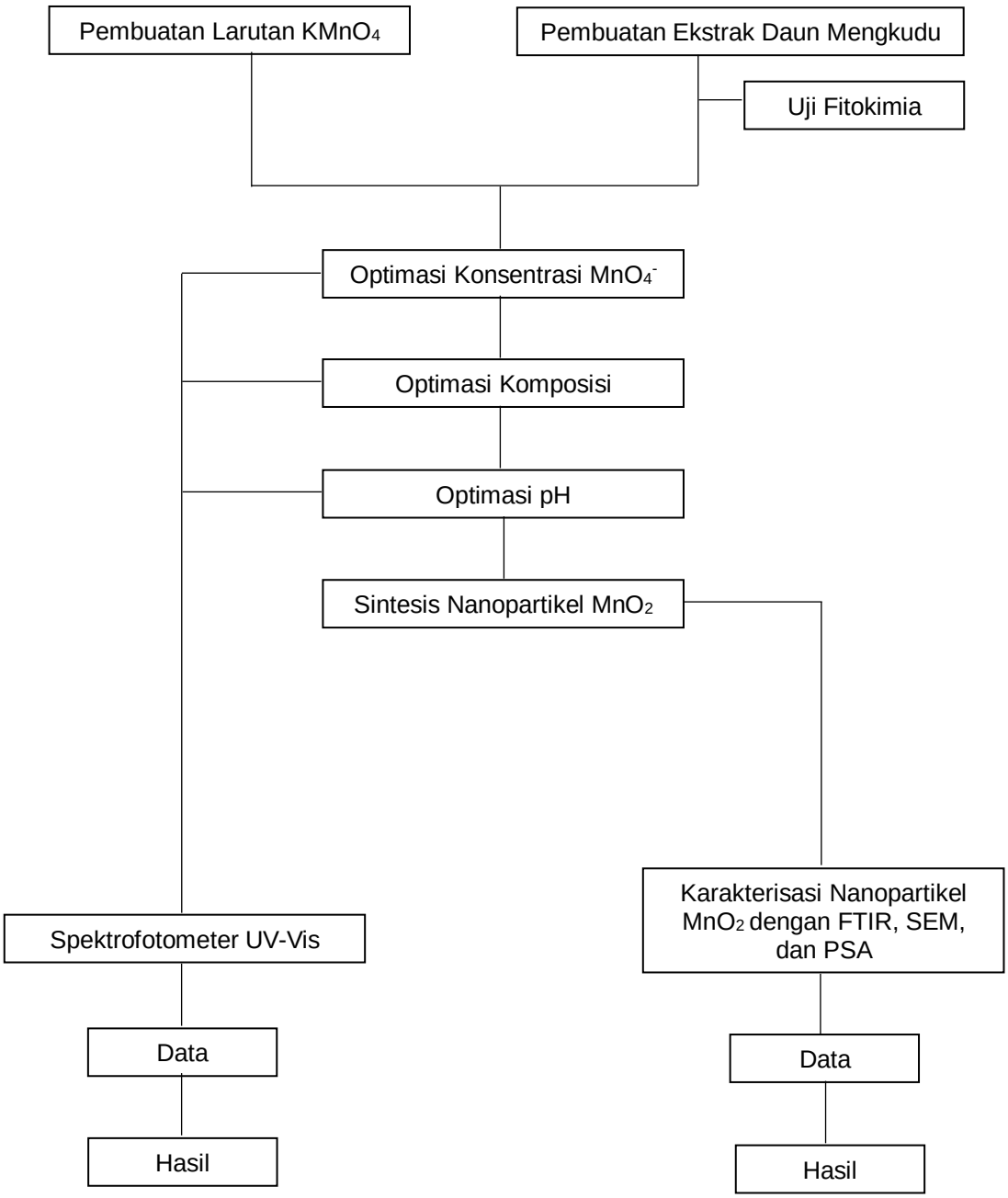
Nugrahani, R., Andayani, Y., dan Hakim, A. 2016 . Skrining Fitokimia dari Ekstrak Buah Buncis (*Phaseolus vulgaris L*.) dalam Sediaan Serbuk. Jurnal Pendidikan IPA, 2(1), 2407-795.

Rahim, D. M., Herawati, N., dan Hasri, H., 2020. Sintesis Nanopartikel Perak Menggunakan Bioreduktor Ekstrak Daun Teh Hijau (*Camellia sinensis*) Dengan Iradiasi Microwave. *Chemica:* Jurnal Ilmiah Kimia Dan Pendidikan Kimia. 21(1), 30-38.

Taba, P., Parmitha, N. Y., dan Kasim, S., 2019. Sintesis Nanopartikel Perak Menggunakan Ekstrak Daun Salam (*Syzgium polyanthum*) sebagai Bioreduktor dan Uji Aktivitasnya sebagai Antioksidan. Indonesian Journal of Chemical Research. 7(1), 51-60. https://doi.org/10.30598/ijcr.2019.7-ptb.

Taniguchi, H., 2004. Braking-radiation: Production of the Acetylacetonate Complex of Technetium. Tesis. Jepang.

Lampiran 1. Diagram Alir Penelitian



Lampiran 2. Perhitungan Pembuatan Larutan

1. Pembuatan larutan $KMnO_4$ 1 mM

W = Mr × V × M

= 158 g/mol × 0,25 L × 0,001 mol/L

= 0,0395 g

2. Pembuatan Larutan $KMnO_4$ 0,75 mM

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 1\ mM = 50\ mL \times 0{,}75\ mM$

$$V_1 = \frac{50\ mL \times 0{,}75\ mM}{1\ mM}$$

$V_1 = 37{,}5\ mL$

3. Pembuatan Larutan $KMnO_4$ 0,5 mM

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 1\ mM = 50\ mL \times 0{,}5\ mM$

$$V_1 = \frac{50\ mL \times 0{,}5\ mM}{1\ mM}$$

$V_1 = 25\ mL$

4. Pembuatan Larutan $KMnO_4$ 0,25 mM

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 1\ mM = 50\ mL \times 0{,}25\ mM$

$$V_1 = \frac{50\ mL \times 0{,}25\ mM}{1\ mM}$$

$V_1 = 12{,}5\ mL$

5. Pembuatan Larutan NaOH 0,5 N

W = BE × V × N

$= 40 \text{ g/eq} \times 0{,}05 \text{ L} \times 0{,}5 \text{ eq/L}$

$= 1 \text{ g}$

6. Pembuatan Larutan HCl 0,5 N

$$N = \frac{\% \times BJ \times 1000}{BE}$$

$$= \frac{37\% \times 1{,}19 \text{ g/mL} \times 1000 \text{ mL/L}}{36{,}5 \text{ g/eq}}$$

$= 12{,}06 \text{ N}$

$V_1 \times C_1 = V_2 \times C_2$

$V_1 \times 12{,}06 \text{ N} = 50 \text{ mL} \times 0{,}5 \text{ N}$

$$V_1 = \frac{50 \text{ mL} \times 0{,}5 \text{ N}}{12{,}06 \text{ N}}$$

$V_1 = 2{,}07 \text{ mL}$

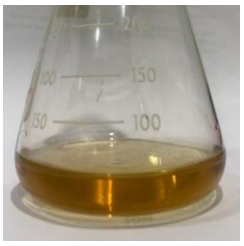
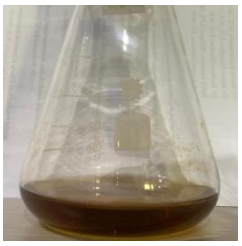
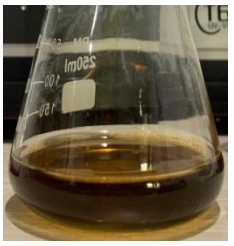
Lampiran 3. Dokumentasi Penelitian

A. Preparasi Sampel

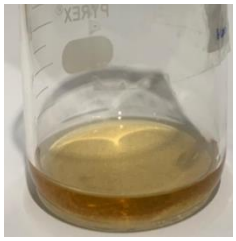
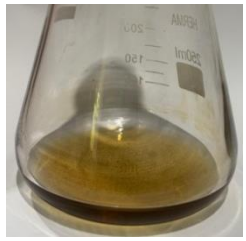
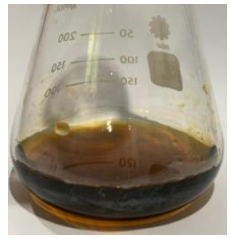


B. Pembuatan Larutan $KMnO_4$


C. Penentuan OptimasiKonsentrasi

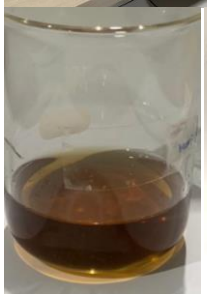
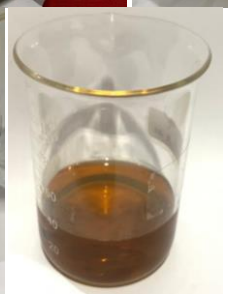





D. Penentuan OptimasiKomposisi

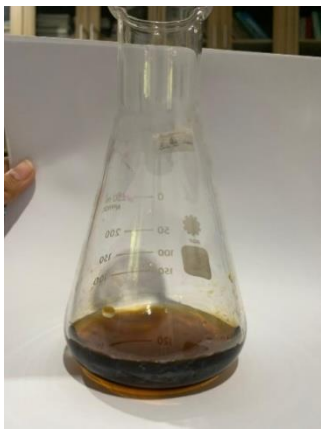




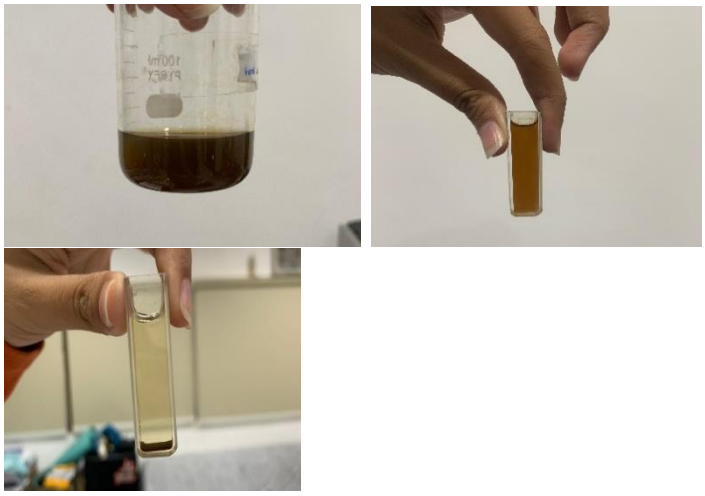

E. Penentuan Optimasi pH



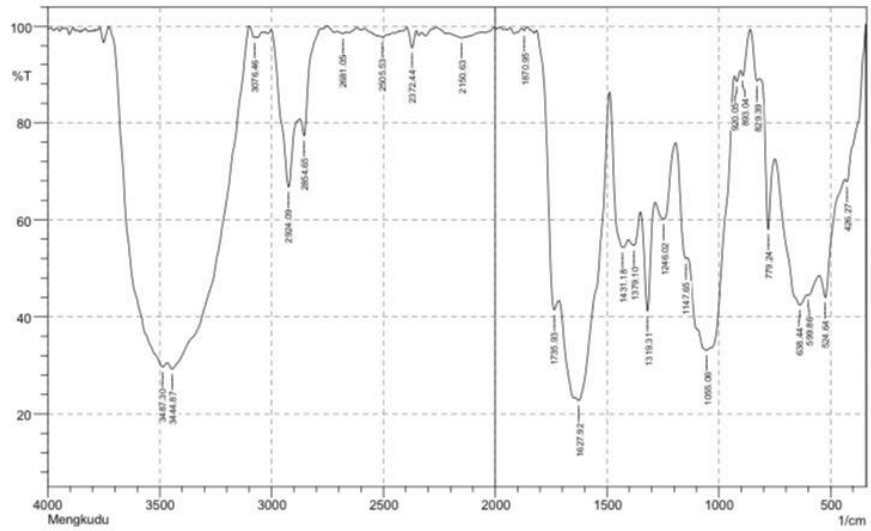
F. Sintesis Nanopartikel MnO_2





Lampiran 4. Hasil Karakterisasi FTIR Daun Ketapang dan MnO_2

SHIMADZU

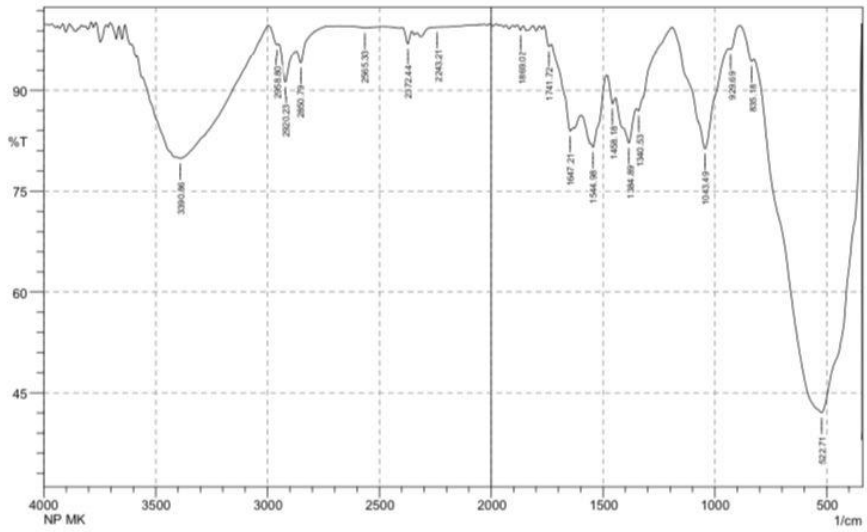


No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	426.27	67.9129	3.6267	435.91	345.26	9.3387	1.7542
2	524.64	44.0266	9.18	551.64	437.84	28.7894	2.2269
3	599.86	44.5178	0.3263	603.72	553.57	16.7623	0.1263
4	638.44	42.43	8.53	748.38	605.65	41.7546	6.5475
5	779.24	58.0979	21.4855	817.82	750.31	9.4079	3.0515
6	829.39	88.6501	2.823	860.25	819.75	1.359	0.2673
7	893.04	89.6816	3.0729	902.69	862.18	1.1641	0.2876
8	920.05	88.5317	1.4628	929.69	904.61	1.2222	0.096
9	1055.06	33.1251	34.2354	1139.93	931.62	72.7759	38.527
10	1147.65	52.0571	2.8007	1192.01	1141.86	10.9387	0.8065
11	1246.02	60.1401	8.6356	1284.59	1193.94	16.9339	2.6551
12	1319.31	41.2324	21.2943	1350.17	1286.52	17.8252	4.8672
13	1379.1	54.7414	3.8862	1404.18	1352.1	12.9228	0.9006
14	1431.18	54.321	10.8892	1487.12	1406.11	17.6729	4.6082
15	1627.92	22.7506	6.1861	1641.42	1489.05	59.7339	7.3955
16	1735.93	41.429	12.8596	1815.02	1716.65	18.6835	2.6581
17	1870.95	99.1218	0.6495	1882.52	1859.38	0.0515	0.0285
18	2150.63	97.6632	1.0648	2208.49	2058.05	1.183	0.3626
19	2372.44	95.658	3.7629	2395.59	2353.16	0.4362	0.3349
20	2505.53	97.8222	1.201	2584.61	2457.31	0.8687	0.3811
21	2681.05	98.5178	0.3984	2708.06	2667.55	0.2227	0.0341
22	2854.65	77.325	7.0238	2872.01	2781.35	4.2186	0.6881
23	2924.09	66.7418	21.3152	3001.24	2873.94	12.4047	6.2194
24	3076.46	97.7299	0.6061	3103.46	3068.75	0.1916	0.0315
25	3444.87	29.2695	5.3212	3466.08	3103.46	116.036	23.1328
26	3487.3	29.6847	5.9626	3728.4	3468.01	83.229	16.6484

Comment;
Mengkudu

Date/Time; 7/16/2024 4:09:27 PM
No. of Scans;
Resolution;
Apodization;

SHIMADZU



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	522.71	42.066	53.598	823.6	345.26	107.581	97.897
2	835.18	94.364	1.039	889.18	825.53	0.837	0.042
3	929.69	96.255	0.618	937.4	889.18	0.446	0.03
4	1043.49	81.347	16.288	1190.08	939.33	11.104	8.769
5	1340.53	86.958	1.035	1350.17	1192.01	4.11	0.1
6	1384.89	82.181	5.638	1442.75	1352.1	6.46	1.433
7	1458.18	88.039	2.001	1483.26	1444.68	1.831	0.157
8	1544.98	81.57	7.479	1597.06	1485.19	7.76	2.238
9	1647.21	83.948	2.232	1730.15	1633.71	4.39	0.219
10	1741.72	96.681	1.187	1764.87	1730.15	0.345	0.09
11	1869.02	99.098	0.662	1884.45	1857.45	0.06	0.033
12	2243.21	99.53	0.01	2247.07	2102.41	0.226	0.024
13	2372.44	97.068	2.075	2397.52	2355.08	0.327	0.178
14	2565.33	99.417	0.215	2636.69	2478.53	0.31	0.055
15	2850.79	94.144	2.361	2872.01	2738.92	1.314	0.211
16	2920.23	91.26	5.313	2949.16	2873.94	1.947	0.76
17	2958.8	96.913	0.543	2999.31	2951.09	0.356	0.017
18	3390.86	79.885	16.726	3583.74	2999.31	34.515	27.822

Comment;
NP MK

Date/Time; 7/16/2024 4:01:38 PM
No. of Scans;
Resolution;
Apodization;

Lampiran 5. Hasil Karakterisasi UV-Vis

A. Data UV-Vis Variasi Konsentrasi

1. 0,25 mM

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	0,492
		525	0,545
		365	0,986
2	1	545	0,484
		525	0,546
		370	1,066
3	3	545	0,440
		525	0,508
		505	0,521
		370	1,288
4	5	520	0,488
		370	1,424
5	10	370	1,544
6	**30**	**370**	**1,797**
7	60	370	1,782
8	90	370	1,683
9	120	370	1,661

2. 0,5 mM

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	0,696
		525	0,760
		370	1,372
2	5	545	0,551
		525	0,627
		370	1,720
3	10	525	0,526
		370	1,962
4	**30**	**370**	**2,243**
5	60	370	2,178
		325	1,498
6	90	370	2,096
		315	1,431
7	120	370	2,047
		325	1,394

3. 0,75 mM

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,049
		525	1,176
		370	2,111
2	5	545	0,949
		525	1,091
		380	2,271
3	10	545	0,845
		525	1,001
		505	1,031
		390	2,485
4	**30**	420	2,622
		395	**2,809**
5	60	415	2,610
		395	2,768
		350	1,402
6	90	415	2,555
		395	2,686
7	120	410	2,557
		395	2,706

4. 1 mM

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,487
		525	1,685
		370	2,158
2	5	545	1,282
		525	1,484
		380	2,541
3	10	545	1,138
		525	1,359
		505	1,382
		410	2,586
		395	2,787
4	**30**	425	2,765
		395	**2,968**
5	60	445	2,703
		435	2,840
		315	1,604
6	90	445	2,671
		435	2,864
7	120	425	2,835
		335	1,481

B. Data UV-Vis Variasi Komposisi

1. 1:10 mL

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	0,437
		525	0,485
		370	2,312
2	5	370	2,292
		315	1,676
3	10	370	2,141
		320	1,620
4	15	370	2,173
		330	1,566
5	30	370	2,003
		325	1,496
6	60	365	0,889

2. 1:20 mL

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,044
		525	1,139
		370	2,123
2	5	545	0,784
		525	0,883
		370	2,405
3	10	525	0,677
		505	0,712
		375	2,446
4	15	370	2,510
		345	1,540
5	30	375	2,467
		340	1,478
6	60	370	2,522
7	90	370	1,285
8	120	370	0,816

3. 1:30 mL

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,433
		525	1,596
		370	2,439
2	5	545	1,213
		525	1,401
		405	2,426
		345	2,106
3	10	525	1,254
		505	1,339
		415	2,669

		395	3,232
4	15	420	2,765
		390	3,111
5	30	420	2,866
		395	3,128
6	**60**	425	2,839
		395	**3,071**
7	90	415	2,816
		395	3,091
8	120	425	2,704
		395	3,004

4. 1:40 mL

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,487
		525	1,685
		370	2,158
2	5	545	1,282
		525	1,484
		380	2,541
3	10	545	1,138
		525	1,359
		505	1,382
		410	2,586
		395	2,787
4	**30**	425	2,765
		395	**2,968**
5	60	445	2,703
		435	2,840
		315	1,604
6	90	445	2,671
		435	2,864
7	120	425	2,835
		335	1,481

C. Data UV-Vis Variasi pH

1. pH 8

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,328
		525	1,456
		370	1,976
2	5	545	1,075
		525	1,194
		370	2,290
3	10	545	0,849
		525	0,968

		370	2,579
4	15	545	0,754
		525	0,875
		505	0,868
		370	2,636
5	30	385	2,640
6	60	385	2,673
7	90	385	2,613
8	120	385	2,581

2. pH 9

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,447
		525	1,590
		365	1,905
2	5	545	1,047
		525	1,169
		370	2,405
3	10	545	0,897
		525	1,020
		370	2,607
4	15	545	0,861
		525	0,982
		370	2,583
5	30	545	0,676
		525	0,800
		505	0,829
		375	2,748
6	**60**	380	2,776
		350	**1,784**
7	90	380	2,848
8	120	380	2,833
9	150	370	2,227
		350	1,675
10	180	370	1,699

3. pH 10

PengukuranKe-	Menit	PanjangGelombang	Absorbansi
1	0	545	1,217
		525	1,322
		370	2,102
2	5	545	0,891
		525	0,991
		370	2,421
3	10	545	0,683
		525	0,788
		375	2,562

4	15	545	0,605
		525	0,709
		505	0,732
		380	2,597
5	30	375	2,722
6	60	380	2.594
7	90	370	2,727
8	120	370	2,006

4. pH 12

PengukuranKe-	**Menit**	**PanjangGelombang**	**Absorbansi**
1	0	605	0,688
		370	2,008
2	3	590	0,329
		370	2,367
3	5	370	2,511
4	**10**	375	2,435
5	15	370	2,345
6	30	370	2,313
7	60	375	2,277

Lampiran 6. Hasil Karakterisasi PSA

Distribusi ukuran nanopartikel pada pengukuran 1

2024.07.05 15:09:43

HORIBA Scientific

HORIBA SZ-100 for Windows [Z Type] Ver2.20

SZ-100

MnO2 P_0066.nsz

Measurement Results

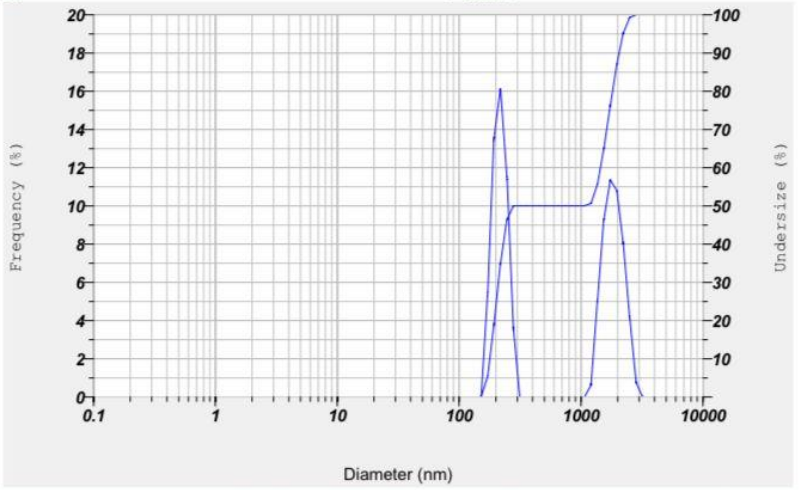
Date	: 05 July 2024 14:18:10
Measurement Type	: Particle Size
Sample Name	: MnO2 P
Scattering Angle	: 90
Temperature of the Holder	: 25.0 deg. C
Dispersion Medium Viscosity	: 0.895 mPa.s
Transmission Intensity before Meas.	: 27335
Distribution Form	: |Standard|
Distribution Form(Dispersity)	: Polydisperse
Representation of Result	: Scattering Light Intensity
Count Rate	: 170 kCPS

Calculation Results

Peak No.	S.P.Area Ratio	Mean	S. D.	Mode
1	0.50	204.7 nm	27.4 nm	204.1 nm
2	0.50	1755.2 nm	332.5 nm	1651.4 nm
3	---	--- nm	--- nm	--- nm
Total	1.00	980.1 nm	810.4 nm	204.1 nm

Cumulant Operations

Z-Average	: 525.9 nm
PI	: 0.674



Distribusi ukuran nanopartikel pada pengukuran 2

2024.07.05 15:09:58

HORIBA Scientific

HORIBA SZ-100 for Windows [Z Type] Ver2.20

SZ-100

MnO2 P_0068.nsz

Measurement Results

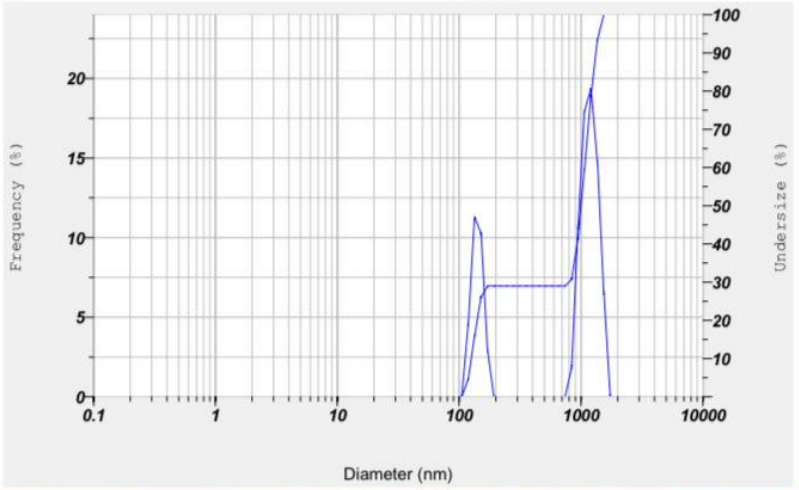
Date	: 05 July 2024 14:19:51
Measurement Type	: Particle Size
Sample Name	: MnO2 P
Scattering Angle	: 90
Temperature of the Holder	: 24.9 deg. C
Dispersion Medium Viscosity	: 0.897 mPa.s
Transmission Intensity before Meas.	: 27335
Distribution Form	: |Standard|
Distribution Form(Dispersity)	: Polydisperse
Representation of Result	: Scattering Light Intensity
Count Rate	: 96 kCPS

Calculation Results

Peak No.	S.P.Area Ratio	Mean	S. D.	Mode
1	0.29	133.2 nm	14.1 nm	130.2 nm
2	0.71	1116.6 nm	172.4 nm	1124.4 nm
3	---	--- nm	--- nm	--- nm
Total	1.00	832.0 nm	469.1 nm	1124.4 nm

Cumulant Operations

Z-Average	: 584.0 nm
PI	: 0.613



Distribusi ukuran nanopartikel pada pengukuran 3

2024.07.05 15:17:24

HORIBA Scientific

HORIBA SZ-100 for Windows [Z Type] Ver2.20

SZ-100

MnO2 P_0079.nsz

Measurement Results

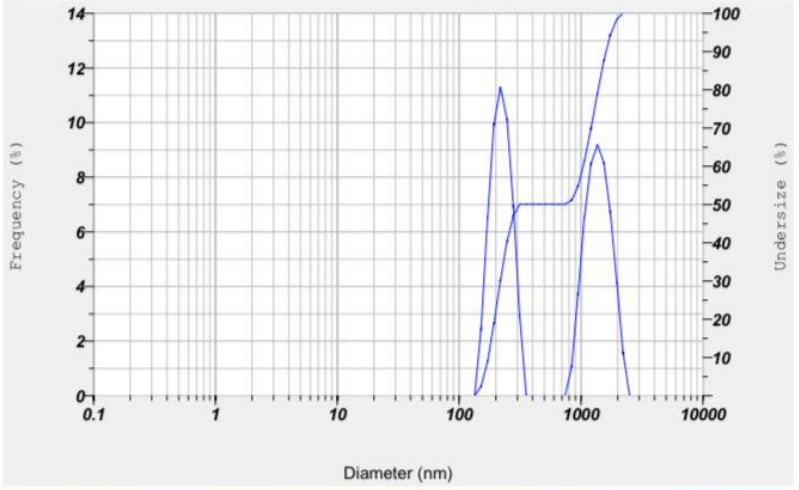
Date	: 05 July 2024 15:16:25
Measurement Type	: Particle Size
Sample Name	: MnO2 P
Scattering Angle	: 90
Temperature of the Holder	: 24.9 deg. C
Dispersion Medium Viscosity	: 0.897 mPa.s
Transmission Intensity before Meas.	: 28357
Distribution Form	: |Standard|
Distribution Form(Dispersity)	: Polydisperse
Representation of Result	: Scattering Light Intensity
Count Rate	: 89 kCPS

Calculation Results

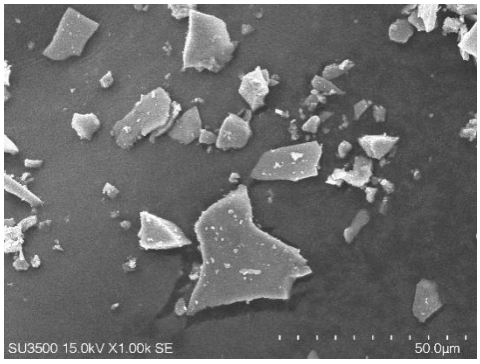
Peak No.	S.P.Area Ratio	Mean	S. D.	Mode
1	0.50	210.6 nm	40.0 nm	205.9 nm
2	0.50	1330.4 nm	311.4 nm	1283.5 nm
3	---	--- nm	--- nm	--- nm
Total	1.00	769.9 nm	602.3 nm	205.9 nm

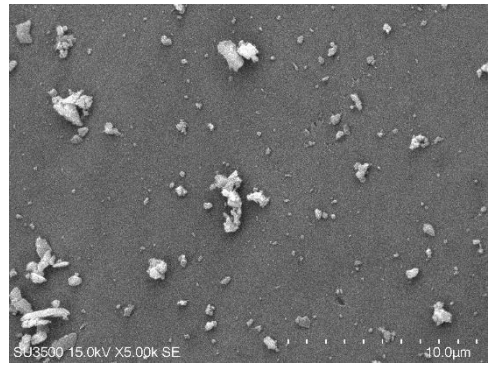
Cumulant Operations

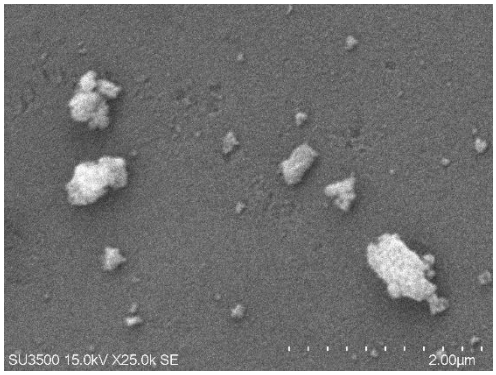
Z-Average	: 490.2 nm
PI	: 0.501

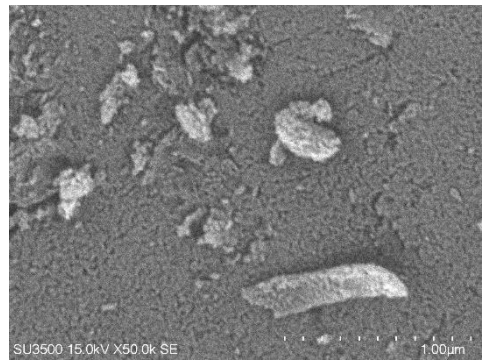


Lampiran 7. Hasil Karakterisasi SEM









EDAX TEAM

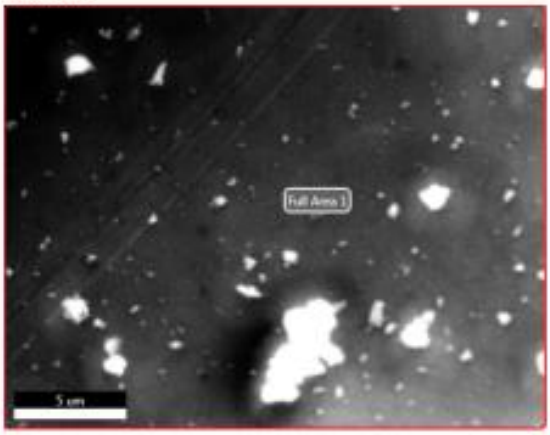
2024

Author: gita

Creation: 8/14/2024 3:02:32 AM

Sample Name: New Sample

Area 239

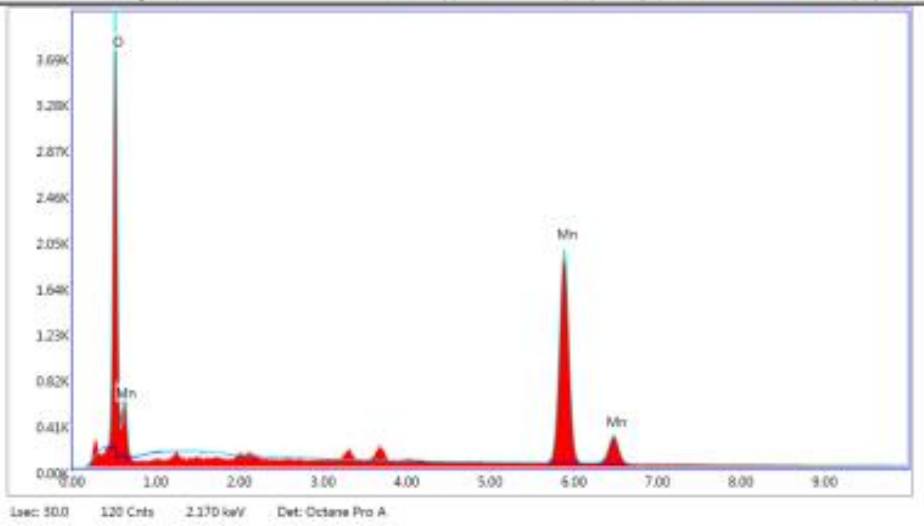


eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.
O K	16.56	40.53	1637.79
MnK	83.44	59.47	1796.55

Full Area 1

kV: 15 Mag: 5000 Takeoff: 87.5 Live Time(s): 30 Amp Time(µs): 0.48 Resolution:(eV) 129.7



Lsec: 50.0 120 Cnts 2.170 keV Det: Octane Pro A